DOCUMENT-IDENTIFIER: US 6097741 A
TITLE: Passively mode-locked fiber lasers

ABPL:
A passive mode-locked linear-resonator fiber laser using
polarization-maintaining fibers and a saturable absorber to
produce ultra short
pulses and a long-term reliable operation with reduced
maintenance. Such a
fiber laser can be configured to produce tunable pulse repetition
rate and
tunable laser wavelength.

BSPR:
Two common mode-locking schemes are active mode locking and
passive mode
locking. Active mode locking modulates either the amplitude or
the phase of
the intracavity optical field at a frequency equal to one or a
multiplicity of
the mode spacing. Active mode locking can be implemented by
using intracavity
electrooptic and acoustooptic modulators.

BSPR:
Alternatively, passive mode locking uses at least one nonlinear
optical element
inside the resonator to produce an intensity-dependent response
to an optical
pulse so that the pulse width of the optical pulse exiting the
nonlinear
element is reduced. Compared to active mode locking, passive
mode locking can
be used to achieve shorter pulses and therefore can be used
advantageously to
produce ultra short light sources. Commonly used passive mode
locking
techniques include saturable absorbers, nonlinear fiber-loop
mirrors (e.g.,
figure eight fiber lasers), and intensity-dependent nonlinear
polarization
rotation. See, Richardson et al., Electronic Letters, Vol. 1,
pp. 542, 1991
and Tamura et al., Electronic Letters, Vol. 28, 2226, 1992.

BSPR:
The present disclosure includes a passive mode-locked fiber laser

with a simple
linear cavity and a saturable absorber to generate femtosecond
pulses with a
peak power up to and greater than tens of watts.

DEPR:
For another example, unwanted feedback to the mode-locked fiber
laser can be
reduced by using wavelength selecting attenuating element as
shown in FIGS.
2A-2C or the isolator 170 in the output fiber 162. The
collimators 121, 114
and any lens (e.g., lens 123), and any light transmitting surface
of the fiber
laser 100 in FIG. 1 may be designed to have a significantly
reduced
reflectivity, e.g., less than 10.sup.-5. The designs shown in
FIGS. 3A-F can
also be used to reduce adverse reflections in the laser
resonator. The free
end of the output fiber 162 can also be cleaved at an angle to
reduce
reflection. A reflecting surface (e.g., a reflective grating or
a mirror) in
the laser resonator should have a high reflectivity at the laser
wavelength and
a low reflectivity at the pump wavelength.

	Type	L #	Hits	Search Text	DBs	Time Stamp	Comments	Error Definition	Errors
57	BRS	L57	39	passive$ adj mode adj lock$ and optical adj resonator	USPAT; US-PGP UB	2001/11/17 13:33		Truncation Overflow. Return string from Server is: 5'0'0'PAS	1
58	BRS	L58	31	57 and ((kerr adj lens) or (saturable adj absorber))	USPAT; US-PGP UB	2001/11/17 14:13			0
59	BRS	L59	1	58 and 372/36.ccls.	USPAT; US-PGP UB	2001/11/17 13:39			0
60	BRS	L60	1	58 and 372/34.ccls.	USPAT; US-PGP UB	2001/11/17 13:40			0
61	BRS	L61	0	58 and 372/35.ccls.	USPAT; US-PGP UB	2001/11/17 13:40			0
62	BRS	L62	1	26 and mode	USPAT	2001/11/17 13:43			0
63	BRS	L63	37	kasamatsu-tadashi.in.	USPAT; US-PGP UB; EPO; JPO; DERWENT	2001/11/17 14:04			0
64	BRS	L64	0	jp11004030	USPAT; US-PGP UB; DERWENT	2001/11/17 13:49			0
65	BRS	L65	83	solid adj state adj laser adj crystal	USPAT; US-PGP UB	2001/11/17 14:05			0
66	BRS	L66	0	65 and passive$ adj mode adj lock$	USPAT; US-PGP UB	2001/11/17 14:06		Truncation Overflow. Return string from Server is: 5'0'0'PAS	1
67	BRS	L67	5	65 and mode adj lock$	USPAT; US-PGP UB	2001/11/17 14:07		Truncation Overflow. Return string from Server is: 5'578172'	1
68	BRS	L68	5	65 and ((saturable adj absorber) or (kerr adj lens))	USPAT; US-PGP UB	2001/11/17 14:08			0
69	BRS	L69	1	57 and kerr adj lens	USPAT; US-PGP UB	2001/11/17 14:12			0
70	IS&R	L70	1	("5987049").PN.	USPAT	2001/11/17 14:13			0
71	IS&R	L71	0	("70 and kerr adj lens and saturable adj absorber").PN.	USPAT	2001/11/17 14:14			0
72	BRS	L72	1	70 and kerr adj lens and saturable adj absorber	USPAT	2001/11/17 14:14			0

	Type	L #	Hits	Search Text	DBs	Time Stamp	Comments	Error Definition	Errors
1	BRS	L1	0	"nd:yag" and resonator and heat adj sink and passive adj mode adj lock$ and disk	USPAT; US-PGP UB	2001/11/17 10:11		Truncation Overflow. Return string from Server is: 5`4463`16	1
2	BRS	L2	0	ndyag and resonator and heat adj sink and passive adj mode adj lock$ and disk	USPAT; US-PGP UB	2001/11/17 10:11		Truncation Overflow. Return string from Server is: 5`175`469	1
3	BRS	L3	0	nd adj yag and resonator and heat adj sink and passive adj mode adj lock$ and disk	USPAT; US-PGP UB	2001/11/17 10:12		Truncation Overflow. Return string from Server is: 5`30878`1	1
4	BRS	L4	0	nd adj yag and resonator and heat adj sink and passive adj mode adj lock$	USPAT; US-PGP UB	2001/11/17 10:12		Truncation Overflow. Return string from Server is: 5`30878`1	1
5	BRS	L5	8	resonator and heat adj sink and passive adj mode adj lock$	USPAT; US-PGP UB	2001/11/17 10:14		Truncation Overflow. Return string from Server is: 5`18548`3	1
6	BRS	L6	134	passive adj mode adj lock$	USPAT; US-PGP UB	2001/11/17 12:49		Truncation Overflow. Return string from Server is: 5`64153`2	1
7	BRS	L7	90	6 and reson$	USPAT	2001/11/17 10:15			0
8	BRS	L8	95	6 and reson$	USPAT; US-PGP UB	2001/11/17 10:15			0
9	BRS	L10	0	9 and ndyag	USPAT	2001/11/17 10:17			0
10	BRS	L11	7	9 and nd:yag	USPAT	2001/11/17 10:19			0
11	BRS	L12	0	thin adj disk and nd:yag and passive and mode adj lock$	USPAT; US-PGP UB	2001/11/17 10:21		Truncation Overflow. Return string from Server is: 5`537326`	1
12	BRS	L13	1	active adj mirror adj lasers	USPAT; US-PGP UB	2001/11/17 10:21			0
13	BRS	L14	7	active adj mirror adj laser	USPAT; US-PGP UB	2001/11/17 10:22			0
14	BRS	L15	1375	mirror adj laser	USPAT; US-PGP UB	2001/11/17 10:23			0
15	BRS	L16	8	15 and passive adj mode adj lock$	USPAT; US-PGP UB	2001/11/17 13:02		Truncation Overflow. Return string from Server is: 5`64153`2	1
16	IS&R	L17	2	(("5553088") or ("5163059")).PN.	USPAT	2001/11/17 10:52			0
17	BRS	L18	1	"5267252".PN.	USPAT	2001/11/17 10:45			0
18	BRS	L19	1	"4990943".PN.	USPAT	2001/11/17 10:45			0
19	BRS	L20	1	"4949342".PN.	USPAT	2001/11/17 10:45			0
20	BRS	L21	1	"4429394".PN.	USPAT	2001/11/17 10:46			0
21	BRS	L22	1	"3753145".PN.	USPAT	2001/11/17 10:46			0
22	BRS	L23	1	"3638138".PN.	USPAT	2001/11/17 10:46			0
23	BRS	L24	1	"3631362".PN.	USPAT	2001/11/17 10:46			0
24	BRS	L25	36	laser adj amplif$ and (crystal or disk) and reson$ and ((heat adj sink) or (cool$)) and mode adj lock$	USPAT; US-PGP UB; EPO; JPO; DERWENT	2001/11/17 11:43		Truncation Overflow. Return string from Server is: 5`530286`	1
25	IS&R	L26	1	("5982792").PN.	USPAT	2001/11/17 11:46			0
26	BRS	L27	0	26 and mode adj lock$	USPAT	2001/11/17 11:46		Truncation Overflow. Return string from Server is: 5`567642`	1
27	BRS	L29	0	26 and passive	USPAT	2001/11/17 11:47			0
28	BRS	L30	0	26 and saturable adj absorber	USPAT	2001/11/17 11:47			0
29	BRS	L28	1	26 and mode	USPAT	2001/11/17 11:49			0
30	BRS	L31	3446	solid adj state adj laser	USPAT; US-PGP UB	2001/11/17 11:50			0
31	BRS	L32	26	31 and passive adj mode adj lock$	USPAT; US-PGP UB	2001/11/17 12:07		Truncation Overflow. Return string from Server is: 5`64153`2	1
32	BRS	L33	134	passive adj mode adj lock$	USPAT; US-PGP UB	2001/11/17 12:07		Truncation Overflow. Return string from Server is: 5`64153`2	1
33	BRS	L34	0	33 and ((thin adj disk adj lasers) or (active adj mirror adj lasers))	USPAT; US-PGP UB	2001/11/17 12:10			0

	Type	L #	Hits	Search Text	DBs	Time Stamp	Comments	Error Definition	Errors
34	BRS	L35	1	((thin adj disk adj lasers) or (active adj mirror adj lasers))	USPAT; US-PGP UB	2001/11/17 12:25			0
35	BRS	L36	0	32 and heat adj sink	USPAT; US-PGP UB	2001/11/17 12:26			0
36	BRS	L37	344	solid adj state adj laser and heat adj sink	USPAT; US-PGP UB	2001/11/17 12:26			0
37	BRS	L38	5	37 and saturable adj absorber	USPAT; US-PGP UB	2001/11/17 12:35			0
38	BRS	L39	437	372/36.ccls.	USPAT; US-PGP UB	2001/11/17 12:35			0
39	BRS	L40	6	39 and saturable adj absorber	USPAT; US-PGP UB	2001/11/17 12:36			0
40	BRS	L41	10	39 and mode adj lock$	USPAT; US-PGP UB	2001/11/17 13:11		Truncation Overflow. Return string from Server is: 5`578172`	1
41	BRS	L42	66726	passive mode adj lock$	USPAT; US-PGP UB	2001/11/17 12:49		Truncation Overflow. Return string from Server is: 5`64153`2	1
42	BRS	L43	0	6 and infrasil adj lens	USPAT; US-PGP UB	2001/11/17 12:50			0
43	BRS	L9	23	8 and ((heat adj sink) or (cool$))	USPAT; US-PGP UB	2001/11/17 12:51		Truncation Overflow. Return string from Server is: 5`706045`	1
44	BRS	L44	0	mode adj master and passive adj mode adj lock$	USPAT; US-PGP UB	2001/11/17 13:02		Truncation Overflow. Return string from Server is: 5`578172`	1
45	BRS	L45	0	mode adj master and passive$ adj mode adj lock$	USPAT; US-PGP UB	2001/11/17 13:03		Truncation Overflow. Return string from Server is: 5`578172`	1
46	BRS	L46	0	thin adj disk adj laser and passive$ adj mode adj lock$	USPAT; US-PGP UB	2001/11/17 13:03		Truncation Overflow. Return string from Server is: 5`537326`	1
47	BRS	L47	0	active adj mirror adj laser and passive$ adj mode adj lock$	USPAT; US-PGP UB	2001/11/17 13:04		Truncation Overflow. Return string from Server is: 5`523544`	1
48	BRS	L48	47	solid adj state adj laser and passive$ adj mode adj lock$	USPAT; US-PGP UB	2001/11/17 13:04		Truncation Overflow. Return string from Server is: 5`764677`	1
49	BRS	L49	1	infrasil adj lens	USPAT; US-PGP UB	2001/11/17 13:13			0
50	BRS	L50	1	infrasil adj (lens or mirror)	USPAT; US-PGP UB	2001/11/17 13:18			0
51	BRS	L51	1	passive$ adj mode adj lock$ and crystal and 372/36.ccls.	USPAT; US-PGP UB; EPO; JPO; DERWENT	2001/11/17 13:21		Truncation Overflow. Return string from Server is: 5`0`0`PAS	1
52	BRS	L52	1	passive$ adj mode adj lock$ and crystal and 372/35.ccls.	USPAT; US-PGP UB; EPO; JPO; DERWENT	2001/11/17 13:21		Truncation Overflow. Return string from Server is: 5`0`0`PAS	1
53	BRS	L53	3	passive$ adj mode adj lock$ and crystal and 372/34.ccls.	USPAT; US-PGP UB; EPO; JPO; DERWENT	2001/11/17 13:23		Truncation Overflow. Return string from Server is: 5`0`0`PAS	1
54	BRS	L54	2	passive$ adj mode adj lock$ and crystal and 372/39.ccls.	USPAT; US-PGP UB; EPO; JPO; DERWENT	2001/11/17 13:25		Truncation Overflow. Return string from Server is: 5`0`0`PAS	1
55	BRS	L55	1	passive$ adj mode adj lock$ and crystal and 372/43.ccls.	USPAT; US-PGP UB; EPO; JPO; DERWENT	2001/11/17 13:26		Truncation Overflow. Return string from Server is: 5`0`0`PAS	1
56	BRS	L56	2	passive$ adj mode adj lock$ and crystal and 372/50.ccls.	USPAT; US-PGP UB; EPO; JPO; DERWENT	2001/11/17 13:31		Truncation Overflow. Return string from Server is: 5`0`0`PAS	1